Claims

[c1]   A method of projecting a pattern from a mask onto a substrate in the lithographic production of microelectronic features comprising:

projecting a pattern from a mask toward an image plane of a substrate using an illuminating energy beam, the pattern projected from the mask having zeroth and higher orders of the energy beam; and

deflecting one or more of the orders of energy beams of the projected mask pattern at an obtuse angle to prevent the one or more deflected order beams from reaching the image plane, while permitting at least one order of the beams of the projected pattern to reach the image plane and form the projected pattern on the substrate.

[c2]   The method of claim 1 wherein the zeroth order beams of the projected mask pattern are deflected, and higher order beams of the mask pattern reach the image plane and form the projected pattern on the substrate.

[c3]   The method of claim 1 wherein zeroth order beams of the projected pattern are diffracted at an obtuse angle.

[c4]   The method of claim 1 wherein the projected mask pat-

tern contains first orders of the energy beam, and wherein the first order beams of the projected pattern reach the image plane.

[c5] The method of claim 1 wherein the projected mask pattern on the image plane has a smaller pitch, compared to a projected mask pattern containing zeroth order beams of the projected mask pattern.

[c6] The method of claim 1 wherein the zeroth order beams of the projected mask pattern are deflected, and the projected mask pattern on the image plane has decreased amplitude, compared to a projected mask pattern containing zeroth order beams of the projected mask pattern.

[c7] The method of claim 1 wherein zeroth order beams of the projected pattern are deflected without heating surrounding optical material through which beams of the projected mask pattern pass and changing index of refraction of the optical material to an extent that affects the projected mask pattern.

[c8] A method of projecting a pattern from a mask onto a substrate comprising:
providing an energy source, a substrate, and a mask containing a pattern of features to be projected onto the

substrate;

projecting an energy beam from the energy source though the mask toward the substrate to create a projected mask pattern image, the projected mask pattern image being created by zeroth and higher orders of the energy beam; and

diffracting zeroth order beams of the projected mask pattern image to an extent that prevents the zeroth order beams from reaching the substrate, while permitting higher order beams of the projected mask pattern image to reach the substrate.

[c9]   The method of claim 8 wherein the zeroth order beams of the projected mask pattern image are diffracted at an obtuse angle.

[c10]   The method of claim 9 wherein the projected mask pattern image contains first orders of the energy beam, and wherein the first order beams of the projected mask pattern image reach the substrate.

[c11]   The method of claim 10 wherein the projected mask pattern image on the substrate has a smaller pitch, compared to a projected mask pattern image containing zeroth order beams.

[c12]   The method of claim 10 wherein the projected mask pat-

tern image on the substrate has decreased amplitude, compared to a projected mask pattern image containing zeroth order beams.

[c13] The method of claim 12 wherein the zeroth order beams of the projected mask pattern image are diffracted without heating surrounding optical material through which beams of the projected mask pattern image pass and changing index of refraction of the optical material to an extent that affects the projected mask pattern image.

[c14] An apparatus for projecting a pattern from a mask onto a substrate in the lithographic production of microelectronic features comprising:

a mask having a pattern thereon;

illumination source for projecting an energy beam to illuminate the mask and projecting the pattern onto an image plane of a substrate, the pattern projected from the mask having zeroth and higher orders of the energy beam;

a pupil filter for modifying the projected mask pattern, the pupil filter having an optical element adapted to deflect one or more of the orders of energy beams of the projected pattern at an obtuse angle to prevent the one or more deflected order beams from reaching the image plane, while permitting at least one order of the beams of the projected pattern to reach the image plane and

form the projected pattern on the substrate.

[c15] The apparatus of claim 14 wherein the optical element is adapted to deflect the zeroth order beams of the projected mask pattern, and permit higher order beams of the mask pattern to reach the image plane and form the projected pattern on the substrate.

[c16] The apparatus of claim 14 wherein the optical element is a diffractive element adapted to diffract zeroth order beams of the projected pattern at an obtuse angle.

[c17] The apparatus of claim 14 wherein the diffractive element is adapted to diffract zeroth order beams of the projected mask pattern image without heating surrounding optical material through which beams of the projected mask pattern image pass and changing index of refraction of the optical material to an extent that affects the projected mask pattern image.

[c18] The apparatus of claim 14 further including a condenser lens between the illumination source and the mask and a workpiece holder for the substrate, and wherein the pupil filter is part of a projector lens system for projecting the mask pattern to reach the image plane and form the projected pattern on the substrate.

[c19] The apparatus of claim 18 wherein the optical element is

a diffractive element adapted to diffract zeroth order beams of the projected pattern.

[c20] The apparatus of claim 19 wherein the diffractive element is adapted to diffract zeroth order beams of the projected mask pattern image without heating surrounding optical material through which beams of the projected mask pattern image pass and changing index of refraction of the optical material to an extent that affects the projected mask pattern image.